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EXPANDED TECHNICAL ASSISTANCE PROGRAM

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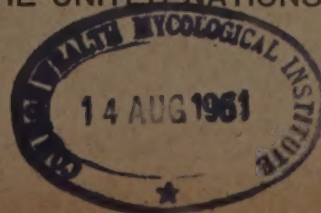
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Report to the
Government of

LIBYA

PLANT PROTECTION

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1960



REPORT TO THE
GOVERNMENT OF LIBYA

ON

PLANT PROTECTION

by

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Rome, 1960

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INTRODUCTION

In accordance with a request of the Government of Libya for technical assistance in developing a program in plant protection and plant quarantine, the Food and Agriculture Organization of the United Nations, under its Expanded Technical Assistance Program, appointed Dr. H. Martin to serve in Libya as Expert in Plant Protection. The expert served in this capacity from 12 July 1952 until 31 December 1959.

The duties of the expert were directed toward the following measures: (1) the conducting of surveys on insects and diseases harmful to growing crops and stored food; (2) the making of biological observations and the consequent conducting of field experiments with a view to establishing economical methods of control for the most important pests; (3) the provision of technical advice on the establishment of phytosanitary legislation; (4) the performance of demonstrations and experiments on control of pests in silos, mills and storerooms, and with fumigation chambers insofar as such activities pertained to plant quarantine measures; (5) the training of local personnel in plant protection techniques; (6) the establishment of field demonstrations of pest control for farmers; (7) the provision of advice to the Government on the establishment of federal services in research, plant quarantines, and extension; and (8) the provision of assistance on the establishment of Plant Protection Sections in the three provinces.

During his stay in Libya the expert was stationed at Sidi Mesri, in the Province of Tripolitania. However, he regularly visited the Provinces of Cyrenaica and Fezzan. Due to the interest and help of the federal and provincial authorities, particularly shown through substantial financial help from the Libyan Public Development and Stabilization Agency, his working conditions were excellent.

In cooperation with local personnel it was possible for the expert to create a fully-staffed and well-equipped Plant Protection Section in Tripolitania, a second one of similar nature in Cyrenaica, and to train and partially equip a third one in Fezzan.

The expert wishes to express his deep appreciation for the cordial cooperation and assistance which he received from His Excellency the Minister of National Economy, the Nazirs of Agriculture for Tripolitania, Cyrenaica and Fezzan, the Director-General of the Ministry of National Economy, the Federal and Provincial Directors of Agriculture, and the General Manager of LPDSA and its entire staff. He also wishes to thank his counterparts, the trainees, assistants, foremen, and all of the plant protection staff who worked with him in a most cordial and effective manner. The many specialists mentioned in the various reports of the expert were of great help in insect and disease identification, and the expert wishes to express his gratitude for their help and assistance.

THE PROBLEM

When the expert arrived in Libya there were no Plant Protection Services at all, - no staff and no available equipment. As a first step it was therefore necessary to create at Sidi Mesri a small plant protection team having the necessary transport, sprayers, dusters, pesticides, labor and optical equipment at its disposal. After this initial organization, the following activities were undertaken, some of them simultaneously and some of them consecutively as demanded by the circumstances:

(a) Regular surveys were conducted in the most important agricultural regions of the three Provinces in order to determine the most important insects and diseases from the economic point of view.

(b) Various people were given training in plant protection in order to provide the country with specialized workers, foremen, assistants and technicians.

(c) Numerous observations were made, and field experiments were conducted, with various pesticides and types of equipment in order to find the best methods of chemical control and in order to give advice accordingly to the Government and to farmers.

(d) At the request of the Government, survey and experimental treatments were made in silos, storerooms, mills and the gas chamber at the port in order to find the best methods of pest control in these special locations.

(e) Government authorities were provided with technical recommendations for a Phytosanitary Law and Bylaw and for other regulations concerned in the import and export of agricultural products.

ACCOMPLISHMENTS

Pests and Diseases Found in Libya

The pests and diseases, as found by the expert, have already been listed in special reports. From an economic point of view the most harmful of the pests are: (1) the Mediterranean fruit fly, Ceratitis capitata (Wied.), on citrus, peaches, apricots, and peppers; (2) the olive fruit fly, Dacus oleae (Gmel.); (3) scale insects on olive, citrus and other fruit trees; (4) red spider and other mites on fruit trees, especially on citrus, almonds and some garden crops; (5) many species of aphids on fruit trees, garden crops, forage and cereals; (6) caterpillars of various species on garden crops, forage and groundnuts; (7) the olive psylla, Euphyllura olivina (Costa), in Tripolitania; (8) the melon beetle, Epilachna chrysomelina F., widespread in all regions; (9) Anartia lineatella L. on stone fruits, and the codling moth, Carpocapsa pomonella (L.), on Pomaceae on the coastal belt and the Gebel; and (10) nematodes which are widespread on garden crops, groundnuts and fruit trees.

Among the many fungi producing diseases of plants the following seem to be among the most important: (1) Oidium spp. on stone-fruit trees and garden crops; (2) Alternaria and Phytophthora spp. on tomatoes and potatoes; (3) various species on the fruit, roots and leaves of groundnuts; (4) Taphrina deformans (Fcl.) Tul. on stone fruits; (5) several species which cause rusts on stone fruits, cereals and some garden crops; and (6) Fusarium spp. on the stems and roots of tomatoes.

Training in Plant Protection

Training courses in plant protection were held at Sidi Mesri or in the field under the supervision of the expert and with the collaboration of qualified assistants. Four courses in olive pruning were held in Tripolitania and Cyrenaica with the collaboration of Tunisian olive pruners.

Treatment and equipment demonstrations were held for farmers and the plant protection staff on many occasions in Tripolitania, Cyrenaica and Fezzan. Charts with photos, graphs and tables were prepared for these courses and for demonstrations concerning the most important pests and diseases.

A collection of plant protection photographs of insects, disease symptoms, treatment techniques and equipment was established for the use of all workers and for purposes of publication.

A number of pamphlets were prepared for the plant protection trainees and for the more advanced farmers. Those which can still be obtained are listed under "Reports Previously Submitted" as an appendix to this report.

Antiparasitic Treatment Program

In order to be able to give recommendations and advice to officials and farmers on the best means of control of pests and diseases, the plant protection teams, under the direction and supervision of the expert, made many biological observations on such insects as the olive fly, Mediterranean fruit fly, codling moth, and various scale insects. Experimental treatments, using up-to-date equipment and all of the insecticides and fungicides available, were also undertaken. The results of this program were included in the regularly-issued Technical Reports, but the most important ones are summarized here as a matter of convenience. During his stay in Libya the expert had opportunities to present some of them at technical conferences such as those dealing with the olive fly, the fruit fly, and date palm insect pests and diseases. Some of them were also published in the FAO Plant Protection Bulletin.

The expert often received requests to establish a general and over-all treatment program. Such a treatment calendar could actually render valuable service provided the work is carried out carefully and by people technically competent. In a country like Libya, in which climatic conditions and cultivation practices may differ considerably from one area to the other, it would be a great mistake to apply a treatment program literally, no matter how good it happened to be. The officer technically responsible should take into account, in each case, not only the development of the disease or pest in a certain area, but also the methods of cultivation and the climatic conditions prevailing.

Treatment of Fruit Nurseries

To bring cryptogamic diseases, cochineals, caterpillars, mites and aphids under control, the following should be applied:

(a) Winter treatment, after shedding of leaves, but before any development of buds: Copper oxychloride 50% w.p. at 1% + parathion at 0.1% (= 0.05% active ingredient). In cases of heavy attack by cochineals, white oil should be added to give a 2% emulsion.

(b) Treatment when buds are well developed, but not yet open: Copper oxychloride 50% w.p. at 0.4% + wettable sulphur at 0.6% + parathion at 0.1% (= 0.05% active ingredient). In cases of attack by rust on almonds, peaches and apricots, treatment with manganese carbamate (maneb) 70% w.p. at 0.2 to 0.3% + sulphur w.p. at 0.3 to 0.4% is advisable.

(c) The above treatment should be repeated, if necessary, once or twice at intervals of 30 days with maneb at 0.2 to 0.3% only.

(d) To control red spider, 0.1% acaricide (Phenkapton, Aramite, etc.) should be added.

Treatment of Stone-fruit Trees

Treatment against cryptogamic diseases, aphids, caterpillars, cochineals, mites and fruit fly is as follows:

(a) Treatment before blossom when buds are still completely closed: Copper oxychloride at 1% + parathion at 0.1% (= 0.05% active ingredient).

(b) Treatment after blossom and after shedding of petals: Copper oxychloride at 0.4% + phosphoric ester (parathion, Diazinon, malathion etc.) at 0.05% a.i. if aphids are still present.

(c) The above treatment should be repeated after 20 to 25 days with copper oxychloride at 0.2 to 0.4% on almonds, apricots and plums, and with copper oxychloride at 0.2% + wettable sulphur at 0.4 to 0.6% on peaches.

It is necessary to cut and burn any dead wood before the first winter treatment is applied.

In cases of heavy attack by cochineals, white oil should be added to winter treatment (a) to provide a 2% emulsion.

In cases of serious damage by Oidium to peach trees, a quantity to provide 0.5 to 0.8% of wettable sulphur should be added to winter treatment (a), but oil should never be added to this mixture.

Treatments against boring insects (Anartia) on almonds, apricots and peaches: Apply first treatment after blossom (calyx spray) with DDT 50% w.p. at 0.4% or phosphoric insecticides (parathion, Diazinon etc.) at 0.05% a.i. Repeat this treatment once or twice at 15-day intervals. This treatment can be combined with (b).

Treatments against fruit fly (Ceratitis) on apricots and peaches: Apply first treatment when the more developed fruits are still green but show a tendency to turn yellow. Use phosphoric insecticides like Diazinon, Rogor, Phosphamidon or Thiomedon at 0.05% a.i. These treatments should be repeated regularly every 8 to 10 days.

Treatment of Pome-fruit Trees

To bring cryptogamic diseases, scale insects, caterpillars and aphids under control, the following treatments should be applied:

(a) Treatment before blossom when buds are still completely closed: Copper oxychloride at 1% + phosphoric insecticide (parathion, Diazinon, etc.) at 0.05% a.i. In cases of heavy attack by scale-insects, add 1.5 to 2% white oil.

(b) Treatment after blossoming (calyx spray): Copper oxychloride at 0.2% + phosphoric insecticide (parathion, Diazinon, etc.) at 0.05% a.i.

In cases of attack by appleworm, a treatment with DDT 50% w.p. at 0.4% should be applied at the first appearance of damage and repeated twice at intervals of 15 to 20 days.

In certain years attacks by caterpillars are heavy. At their first appearance a treatment with DDT 50% w.p. at 0.4%, or parathion at 0.1%, should be applied.

The Zeuzera insect may cause damage in orchards. If this is the case, a few crystals of paradichlorbenzene, a solution of BHC at 1%, or mineral oil should be introduced into the galleries housing the larvae. After this treatment the galleries should be blocked with damp earth or grafting mastic.

Pears, maturing late, are often exposed to attacks by fruit flies. The damage generally appears before harvest when the fruit has reached a certain stage of maturity. A treatment with DDT 50% w.p. at 0.5% should be applied and repeated once or twice at 15-day intervals.

Treatment of Olive Trees

(a) Treatment against cochineals of the twigs and leaves: After pruning, but before blossom, a treatment with white oil at 1.5 to 2% + phosphoric insecticide (Diazinon, malathion or parathion) at 0.05% a.i. should be applied. Should there be a serious attack, the treatment should be repeated after 15 to 20 days. If sooty mold (fumagine) appears, copper oxychloride at 0.2% should be added.

(b) Treatment against olive psyllid (bombacella) in Tripolitania only: At first sign of infestation, a treatment with BHC (lindane) dust or a spray of nicotine or phosphoric insecticide (parathion, malathion, Phosphamidon, etc.) at 0.05% a.i. should be made.

(c) Treatment against olive-tree beetle, Zonabris, in Cyrenaica only: At the appearance of this insect, DDT 50% w.p. at 0.4% or BHC (lindane) 50% w.p. at 0.2% or phosphoric insecticide (parathion or malathion) at 0.05% a.i. should be applied.

(d) Treatment against the olive fly: When 5 to 10% of the olives show larvae of the first stage, the first treatment should be applied. It should be repeated once or twice, as required, at intervals of 30 to 40 days. For the first treatment a phosphoric insecticide (Diazinon, Rogor, Phosphamidon or Thiometon) at 0.05% a.i. is recommended; for the second a concentration of 0.04% a.i.; and for the third treatment a concentration of 0.03% a.i. The last treatment should be applied not later than 35 to 40 days before harvest.

Treatment of Citrus Trees

(a) Against cochineals and scale insects: After the harvest and the clean-pruning, but before budding or, in case of late harvesting, after blossom when the fruits are the size of a nut, white oil 1.5-2% or white

oil 1.5% + phosphoric insecticide (parathion, Diazinon, etc.) at 0.05% a.i. should be applied. If attack is heavy, the treatment should be repeated after 15 to 20 days.

(b) Against red spider mites: At first appearance of the spider, a treatment of an acaricide (Phenkapton, Aramite, etc.) should be applied at a concentration recommended by the manufacturer. If attack is heavy, the treatment should be repeated after 15 days. It can be combined with (a) or (c).

(c) Against fruit fly (Ceratitidis): The first treatment should be applied as soon as the most advanced fruits show bites (punctures), varying from early August to early October according to the area, the year and the citrus variety. During recent years the attack of Ceratitidis has started in the coastal region (Tagiura to Sorma in Tripolitania, Benghazi and Derna in Cyrenaica) from early August to early September, while in the interior (Suani, Castle Benito, Azizia, Jordani in Tripolitania and Barce in Cyrenaica) it has started from the middle of September to early October. In areas not infested by red spider, DDT 50% w.p. at 0.4% to 0.5% should be applied. In regions infested by red spider it is advisable to add to the DDT mixture an acaricide (Phenkapton, Aramite, etc.) at 0.1% or, better, to use a phosphoric insecticide (Diazinon, Phosphamidon, Rogor, etc.) at 0.05% a.i. According to the seasonal development of the pest, it may be necessary to repeat this treatment 2 to 4 times at intervals of 15 to 20 days.

Treatment of Vines

The treatment against vineworms and fungus diseases is strictly related to the climatic conditions of the region concerned and one should be very careful in recommending treatments in general. The vineworm is principally found in the coastal area at Lathrum, Derna and Tobruk in Cyrenaica; Oidium is common in the coastal belt, of both Tripolitania and Cyrenaica; and mildew causes damage principally in the region of Tripoli and in the Cyrenaica Gebel.

(a) Treatment against the vineworm: 10% DDT dust or a spray of DDT 50% w.p. at 0.4% should be applied just before blooming and repeated after 10 to 15 days. At the time when grapes are attacked by worms (second generation) this treatment should be repeated 2 to 3 times at intervals of 10 to 15 days.

(b) Treatment against Oidium: At the first appearance on leaves or grapes an application should be made of sulphur dust or of spray with wettable sulphur at 0.4 to 0.6% + copper oxychloride at 0.2%. It should be repeated 2 to 3 times at 15 to 20-day intervals. It is necessary to dust or to wet the grapes very well, preferably making the treatment in the early morning.

(c) Treatment against mildew: Damage by mildew may vary considerably from one year to another and from one region to another. It is therefore impossible to make general recommendations for its control. However, in the area generally affected by mildew an application of a first treatment should

be made, shortly before blooming, of a solution consisting of lime + 1.0 to 1.5% copper sulphate (Bordeaux-mixture), or copper oxychloride at 0.4% to 0.6%. This treatment should be repeated once or twice according to climatic conditions.

Treatment of Date Palms

(a) Treatment against spider mites: On the appearance of the spiders, generally in June, an application should be made with sulphur dust or with an acaricide such as Phenkapton. This treatment should be repeated once or twice at an interval of 20 to 25 days. It is necessary to dust abundantly each cluster of dates.

(b) Treatment against scale-insects: Treatments are only recommended for the experimental gardens or for young trees of high quality. After harvesting an application should be made of white oil at 1.5% + phosphoric insecticide (Diazinon, malathion or parathion) at 0.05% a.i.

(c) Treatment against cryptogamic disease of inflorescences (Mauginiella): Diseased inflorescences should be removed and burned. Before blooming a dust of cupric fungicide (copper oxychloride or copper carbonate) should be applied at the base of the palm (heart).

Treatment of Forage Crops

Treatment against aphids and caterpillar: Infested areas should be dusted, after harvesting, with BHC (lindane). If there are still aphids or caterpillars present when the crop is about 5 to 10 cm high, a liquid treatment with malathion at 0.1% or nicotine (nicotine sulphate 15% at 0.5 to 1%, or Nicotox at 0.3%) should be applied, but this not later than 8 days before harvesting.

Treatment of Garden Crops

(a) Treatment against aphids and thrips: Spray applications should be made with malathion or nicotine insecticides, but not later than about a week before harvest.

(b) Treatment against caterpillars: If the above recommended treatment is not effective, an application of BHC (lindane) dust, or of DDT dust, should be made.

(c) Treatment against cutworms and mole-cricket: A bait mixture of 4% BHC in bran should be spread on the soil.

(d) Treatment against beetles and powdery mildew: Applications should be made of a mixture containing half sulphur powder and half 10% DDT dust.

(e) Treatment against red spider mites: Applications should be made of sulphur dust or of some other acaricide such as Phenkapton.

(f) Treatment against fruit flies and diseases on fel-fel pepper: When the first sign of damage appears, an application of DDT 50% w.p. at 0.4% should be made. This treatment should be repeated every 20 days. Against Oidium and Cercospora of the leaves, copper oxychloride at 0.4% + wettable sulphur at 0.6%, or zinc or manganese carbamate (zineb or maneb) at 0.3% + wettable sulphur at 0.5%, should be added to the above treatment.

(g) Treatment against Alternaria and Phytophthora on potatoes: Alternaria is widespread in most of the regions, while Phytophthora is more-or-less localized in the Tripoli-Suani-Zavia area. The carbamate fungicides are more effective against Alternaria, while copper is more effective against Phytophthora. A first treatment should be made when the plants have reached a height of 10 to 15 cm. According to climatic conditions and sensitivity of the potato variety, this treatment should be repeated 2 to 3 times every 15 days in autumn and winter, and every 15 to 20 days in spring and summer. Against Alternaria, carbamates (zineb, maneb etc.) at 0.15 to 0.20% a.i. should be used; to bring both Alternaria and Phytophthora under control, a fungicide mixture of zineb or maneb at 0.1 to 0.2% a.i. + copper oxychloride at 0.2 to 0.3% a.i. should be used.

(h) Treatment against fungus diseases on tomatoes (Alternaria, Phytophthora, and Septoria): To prevent these diseases one should use combined fungicides of carbamate and copper, e.g., zineb or maneb at 0.15 to 0.20% a.i. + copper oxychloride at 0.2 to 0.3% a.i. 1 to 3 applications should be made to the seed-beds at intervals of 10 to 15 days and 2 to 4 applications to the fields at intervals of 15 to 20 days.

The use of highly toxic products should be avoided. Regulations of the Sanitary and Phytosanitary Law regarding sale, use and time of treatment of any antiparasitic compound should be strictly observed. Recommendations should be followed very closely as to dosages, times and numbers of applications.

As a result of the field experiments and demonstrations on which the foregoing recommendations are based, practical solutions to the following problems may be considered as having been obtained: the olive fly; the fruit fly on citrus, apricots, peaches and peppers; scale-insects on olive and fruit trees; red spider mites on citrus, other fruit and palm trees; olive psylla; Carpocapsa on Pomaceae; Anartia on stone-fruit trees; aphids on fruit trees, vegetables and lucerne; vineworm; caterpillars on vegetables and lucerne; cutworms and mole-crickets; and fungus diseases caused by Phytophthora, Alternaria and Septoria on potatoes and tomatoes. Encouraging results were also obtained in efforts to control root-infesting nematodes and fruit diseases of groundnuts. Furthermore, a special campaign was organized in Tripoli to demonstrate the efficacy of cyanide fumigation of citrus trees under tents in the control of scale-insects.

Demonstrations of Fumigation Techniques

At the request of the Government, the expert made a survey of the insect pest problems which occur in the silos, mills and storerooms of Tripolitania and Cyrenaica. With the collaboration of a specialized team, disinfestation programs employing methyl bromide were organized to demonstrate control in these specialized types of situations. In collaboration with chemists and engineering consultants the expert also conducted trials of control in the gas chamber at the Tripoli harbour. Results of the treatment of citrus were not always satisfactory.

Advice on Legislative and Administrative Matters

On many occasions the expert had the pleasure of advising the Federal and Provincial Governments on such legislative or administrative matters in plant protection as the preparation of the technical draft for the Phytosanitary Law and Bylaw, regulations for the import and export of potatoes, and regulations for the export of citrus and groundnuts. He was also asked to give advice on the organization of Plant Protection Services on both federal and provincial levels. These included Plant Quarantine, Research and Extension Services. Likewise, he made every effort to be helpful in the rendering of advice on the creation and organization of the Plant Protection Cooperative in Tripoli.

SUGGESTIONS AND RECOMMENDATIONS

The damage caused to crops and stored foodstuffs by pests and disease is very great in the agricultural economy of Libya. Furthermore, steps taken by countries importing Libyan produce are rendering international trade more and more subject to the strict application of phytosanitary regulations. Both federal and provincial authorities have always demonstrated a great interest in the problems of plant protection and plant quarantine, and the Plant Protection Services are already doing excellent work in the three Provinces. However, it is advisable to further reinforce and develop these Services according to financial and technical possibilities. The creation or development of the following services and programs is therefore recommended:

Federal Office of Plant Protection and Plant Quarantine

A Federal Office of Plant Protection and Plant Quarantine should be established to deal with the following matters: (1) the preparation of laws and regulations concerning plant protection and plant quarantine, and with the supervision of their enforcement; (2) the solution of technical problems such as international regulations, participation in scientific conferences, etc., which involve relationships with foreign countries; (3) the coordination and supervision of all activities relating to plant protection and quarantine; and (4) participation in the preparation of that part of the federal budget concerning plant protection and grants-in-aid to the provinces.

The Federal Office should at first be composed of one senior phytosanitary official, with a university degree and a considerable amount of experience in the field of plant protection, and one secretary-assistant. It should be provided with all the necessary documentation concerning national and international phytosanitary regulations currently in force.

Provincial Phytosanitary and Plant Quarantine Services

The provincial services should come under the supervision of the Federal Government because of its international responsibilities. The expert has previously recommended, both at Tripoli and at Benghazi, the establishment of an office staffed by one graduate phytosanitary official, with experience, and one non-graduate assistant with considerable technical and practical experience. Quarters for each office should include a laboratory with the necessary equipment (binocular microscope and other normal laboratory equipment), and also contain the relative documents, regulations, etc.

The proposed office in each province should exercise control over the exports and imports at all points of entry (seaports, airports and highways) of all plants, fruits and vegetables according to the phytosanitary laws and regulations. It should also grant the necessary phytosanitary certificates for the export and import of all vegetable products so as to ensure that they conform to the laws and regulations. It should

also enforce, in collaboration with the research and extension services, the quarantine regulations. Further it should control, in collaboration with the Federal Office and the Provincial Research Centers, the sale permits for anti-pest products and the use of these products. This Service should have supervision of the phytosanitary use of the gas chamber in the port and should give technical advice on the storage of cereals and other foods.

Provincial Research Centers

Since 1952 numerous research projects have been undertaken almost exclusively by the plant protection section of FAO in collaboration with the Naziras of the three Provinces. The aims of these projects have been as follows: (1) the biological study of the principal pests and diseases of crops, both in the field and in the laboratory; (2) determination of the most effective and economical methods of pest control; (3) inspection of the various agricultural districts to determine the development, spread and propagation of plant pests and diseases; (4) the testing of anti-pest products with a view to granting permits for the sale and use of these products and to recommending the proper methods of application; and (5) the giving to the provincial extension services of detailed and specialized crop-treatment programs, and also the providing of the agricultural college staff with scientific and technical information and practical demonstrations. It is clear that such a varied and important program necessitates a well-qualified staff, well-equipped laboratories, and field application on a large scale; - all of which require considerable expenditure. It is therefore recommended that, in order to avoid all wasteful practices and duplication of effort, there should be chosen for each major research section a center most suitable for these research projects, keeping in mind the various crops to be studied and the possibility of achieving successful results.

The Provinces, in particular Tripolitania and Cyrenaica, should themselves be entrusted with these projects and be given considerable Federal grants-in-aid. This would naturally imply the correlation and supervision of projects by officials of the Federal Office.

To realize the aims of this program the following organization would be required at each center:

Entomological Section

This section should be concerned with the control of insect pests, mites, nematodes, and gastropods. It should consist of the following:

One or more experienced graduate entomologists.

One or more assistants with some technical knowledge and field experience.

One or more laboratory servants.

A laboratory with such equipment as a microscope, one or two binocular microscopes, laboratory utensils, air-conditioned observation chambers, and chemicals.

An insectarium with breeding cages.

An office containing a reference library.

Phytopathological Section

This section should be concerned with the control of cryptogamic, bacterial, virus, deficiency and other types of plant diseases. It should consist of the following:

- One or more experienced graduate plant pathologists.
- One or more assistants with some technical knowledge and field experience.
- One or more laboratory servants.
- A laboratory with such equipment as a microscope, one or two binocular microscopes, microtome, laboratory utensils, autoclave, and chemicals.
- A greenhouse and air-conditioned observation chambers.
- An office containing a reference library.

Work Teams, Transport and Equipment

Each of the foregoing sections should have the following at its disposal: two cars, two foremen, four skilled labourers, two motorized sprayers, one atomizer, two wheelbarrow sprayers, two knapsack sprayers, two hand sprayers, two motorized dusters, several hand dusters, one motorized soil-injector, two hand soil-injectors, sundry crop-treatment utensils, tools and materials for maintenance of equipment, pesticides, and two storerooms for equipment and chemicals.

Education and Staff Training

For the edification of the public, for the use of workers already engaged in plant protection work, and to provide an adequate number of trained workers for future positions the following should be provided:

(a) By the University Faculty of Science: theoretical courses, laboratory work in entomology, mycology, bacteriology, toxicology, etc., including demonstrations and visits to farms.

(b) By the Agricultural Schools: courses in plant protection (both entomology and phytopathology), field demonstrations, the recognition of insect pests and diseases, and practice in the application of plant protection measures.

(c) By the Provincial Phytosanitary and Plant Quarantine Services: short courses in plant protection, and field demonstrations for members of the Extension Service.

(d) By the Phytosanitary Services and the Research Centers: pamphlets on plant protection for use in agricultural schools, by the personnel in the Extension Services and by 'up-to-date' farmers; lectures and demonstrations in the various districts of their provinces; and cooperation with the press and the radio in giving simple advice in the practice of plant protection.

While certain services and institutions have been designated as being responsible in the foregoing, it is obvious that cooperation of all in any particular line of endeavor should be encouraged.

Extension Services

Each Province should participate, as far as its technical and financial resources permit, in the Extension Services. The expert has previously had occasion to submit various recommendations concerning this subject. In brief, it is recommended that extension services be organized to: (1) instruct growers in the best methods of combatting insect pests and diseases; (2) make available to growers, at moderate cost, spraying teams or hand equipment; and (3) organize and direct control campaigns when necessary. Some of the program could be carried out in collaboration with the agricultural cooperatives although the technical aspects of the Services should be supervised by the Provincial Phytosanitary and Plant Quarantine Services and the Provincial Research Centers. In any case, it will be necessary to organize teams with the essential equipment and trained workers as follows:

Tripolitania

Two or three teams should be stationed at Tripoli and one at Misurata. Each team should be composed of one foreman who is well-trained in plant protection, one driver-mechanic, and two skilled labourers. It should have at its disposal one car, one motorized sprayer, one wheelbarrow sprayer, knapsack sprayers, hand dusters, etc. It should have storerooms for equipment and chemicals. The teams should be under the control of the Chief of the Plant Protection Extension Services. Some of the equipment and pesticides could be placed at the disposal of the general extension services and government farms as soon as their personnel are able to make proper use of them. This would apply especially at Ghadames, Garian, Tarhuna, Zavia, Homes, Zleeten, and Misurata-Zaviet.

Cyrenaica

Teams similar to those in Tripolitania, and with the same equipment, etc., should be stationed at Benghazi, Barce and Derna. Equipment and pesticides should also be made available at Messa or Beida, Jalo and Kufra.

Fezzan

Teams should be stationed at Hun, Brack and Sabha with equipment and pesticides also available at Ghat, Murzuk and Tragen.

APPENDIX: REPORTS PREVIOUSLY SUBMITTED

During the course of the expert's stay in Libya, many reports were written on the various aspects of plant protection with which he was concerned. The following documents are still obtainable from the FAO Mission, P.O. Box 979, Tripoli, Libya:

- 1953. Martin, H. Le cocciniglie degli agrumi in Libia. (Italian, Arabic)
- 1954. Martin, H. and Carraro, G. Cyanidric fumigation of citrus in Tripolitania. (English, Italian, Arabic)
- 1954. Martin, H. La Protection des Plantes, Introduction technique générale. (French, English, Italian, Arabic)
- 1956. Combremont, R. et Zine, I. Taille, rajeunissement et entretien des oliviers. (French, Arabic)
- 1956. Martin, H. Insectes nuisibles aux denrées entreposées et méthodes de lutte. (French)
- 1956. Martin, H. Maladies et insectes nuisibles aux Arachides en Libye. (French)
- 1959. Carraro, G. Contributo alla conoscenza dei nematodi delle piante coltivate in Tripolitania. (Italian)
- 1959. Carraro, G. Ricerche e prove sperimentali sul fenomeno di deperimento delle piante di agrumi in Tripolitania. (Italian)
- 1959. Martin, H. Experimental trials and control tests in the gas chamber, Tripoli. (English)
- 1959. Martin, H. Insectes nuisibles aux denrées entreposées et méthodes de lutte. (French)
- 1959. Martin, H. et Carraro, G. Maladies et insectes nuisibles aux Arachides en Libye. (Italian)
- 1959. Martin, H. Observations phytosanitaires et Protection des plantes en Cyrenaïque. (French)
- 1959. Martin, H. Observations phytosanitaires et Protection des plantes en Fezzan. (French)
- 1959. Martin, H. Observations phytosanitaires et protection des plantes en Tripolitaine. (French, Italian)
- 1953-59. Martin, H. Rapports techniques concernant observations biologiques et essais de traitements dans les cultures. (French)
- 1959. Martin, H. Ravageurs et maladies du Palmier dattier en Libye. (French, English, Arabic)

